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TRENDS IN CAUSE AND BIRTHWEIGHT-SPECIFIC INFANT MORTALITY IN NORTH CAROLINA, 1987-88 TO 1991-92

by

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ABSTRACT

Between 1987-88 and 1991-92, infant mortality declined dramatically in North Carolina. This study examines trends in infant mortality according to cause of death and infant birthweight, to identify those areas that contributed most to the improvement in birth outcomes noted in the state during this period. Mortality data for these time periods were compared, using matched live birth and infant death certificates.

During this period, the reduction in infant mortality was attributable to improvements in birthweight-specific survival rather than to changes in the birthweight distribution; the percentage of low and very low birthweight births actually increased slightly during this time. The magnitude of the decline in mortality was similar for infants delivered very low birthweight, moderately low birthweight, and normal birthweight. Improved survival of low birthweight infants accounted for about 60 percent of the overall decline in infant mortality during this period, while improvements in mortality among normal birthweight infants accounted for about 40 percent of the decline.

Reductions in the risk of death for a variety of causes contributed to the overall improvement in infant mortality, although the experience of white and minority infants differed in this regard. A decreased risk of mortality due to congenital malformations and respiratory distress syndrome were the major factors responsible for the overall decline in infant mortality among whites, while for minorities, decreases in deaths from sudden infant death syndrome (SIDS) and "other perinatal conditions" accounted for a large proportion of the decline. Minority infants had a higher risk of mortality than white infants for each cause of death, but the differences were particularly pronounced for causes of death associated with extreme prematurity.

The findings of this study—that reductions in infant mortality occurred among all birthweight groups and among a wide variety of causes of death—suggest that no single strategy was responsible for the overall decline in infant mortality seen in these years. These findings suggest that, if birth outcomes are to continue to improve, a broad range of interventions will need to be pursued aggressively. Efforts directed at preventing the three leading causes of infant death—birth defects, low birthweight, and SIDS—hold the greatest potential for achieving further significant reductions in infant mortality.

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INTRODUCTION

In 1992, North Carolina reported an infant mortality rate of 9.9 deaths per 1,000 live births, placing the state 43rd in the nation in infant mortality. Four years earlier, in 1988, North Carolina ranked 49th in the nation with a mortality rate of 12.6. The infant mortality experience of 1988 attracted considerable concern, and provided much impetus for programmatic improvements in maternal and child care. These improvements included expansion of Medicaid coverage for pregnant women, statewide implementation of maternity care coordination, and several legislative initiatives. However, the overall effect of these interventions on the state's infant mortality rate has not been fully studied.

The purpose of this descriptive study is to examine recent trends in cause- and birthweight-specific infant mortality to determine the contribution that each of these components has made to the overall decline in the infant death rate. Analysis of changes in mortality within specific birthweight groups or by cause of death may allow inferences to be drawn concerning which interventions may have had the greatest impact on infant mortality, and can help identify areas where additional preventive efforts may be most needed to sustain the decline.

METHODS

Using data from computer-matched live birth and infant death certificates, we compared the mortality rates of infants born in 1987-88 with that of infants born in 1991-92. These two periods represent, respectively, the highest and lowest two-year infant mortality rates since the mid-1980s. Because the mortality data in this report are based on the infant's year of birth rather than year of death, the mortality risks will vary slightly from those published in the standard N.C. vital statistics reports. In addition, the mortality data for the 1992 birth cohort are based on provisional files and therefore may differ slightly from the actual infant mortality risks for this birth cohort. Because of the disparity in infant mortality by race, separate analyses were carried out for white infants and for minority infants (about 92 percent of minority births are black).

Mortality risks were expressed as the number of infant deaths per 1,000 live births. Birthweight-specific mortality risks (risk of death for infants of a given birthweight) were determined for infants delivered very low birthweight (500-1,499 g), moderately low birthweight (1,500-2,499 g), and normal birthweight (≥2,500 g). A method for partitioning differences in mortality rates was used to determine the percentage of the decline in overall infant mortality that was attributable to improved survival within specific birthweight categories.[1]

Cause-specific mortality risks (risk of death from a specific cause) were based on a grouping of the ICD-9 codes for the underlying cause of death. For each cause of death, the effect on the total reduction in infant mortality was determined by dividing the absolute change in the mortality risk for that cause by the absolute decline in overall mortality.

RESULTS

Among white infants, the infant mortality risk declined by 21.4 percent between 1987-88 and 1991-92, from 9.4 to 7.4 per 1,000 live births. For black and other infants, the mortality risk decreased from 18.3 to 15.6, representing a 14.8 percent decline. Throughout the period, there remained a two-fold disparity in mortality between minority and white infants.

Trends in Low Birthweight

Table 1 shows the birthweight distribution, by race, for live-born infants delivered in 1987-88 and 1991-92. The rate of low birthweight increased slightly among both whites and minorities over this time period. For whites, the low birthweight rate increased by 6.7 percent; among minorities the increase was 5.8 percent. The increased low birthweight rate for each race was due to an increase

in the rates of both very low birthweight and moderately low birthweight infants. The percentage of births less than 500 g remained the same for both races.

The rate of low birthweight among blacks and other minorities was twice that of whites in both time periods. Toward the extreme low end of the birthweight spectrum, the racial differences are even more pronounced. Among minorities, the percentage of infants delivered very low birthweight was about 2.6 times that of whites, while the percentage of births under 500 g was four times as high as that of whites.

Trends in Birthweight-Specific Infant Mortality

Table 2 presents infant mortality risks by race and birthweight for infants born in 1987-88 and 1991-92. Shown in the far right-hand column of the table, is the percent of the total decline in infant mortality for each race that was attributable to improved survival among infants within a particular birthweight category.

Table 1
Percentage of Resident Live Births by Birthweight and Race, North Carolina
1987-88 and 1991-92 Birth Cohorts

Birth-weight (g)	*White*		*Black and Other*	
	1987-88	1991-92	1987-88	1991-92
<2,500	6.0	6.4	12.0	12.7
<500	0.1	0.1	0.4	0.4
500-1,499	0.9	1.0	2.4	2.6
1,500-2,499	5.0	5.3	9.3	9.8
≥2,500	94.0	93.6	88.0	87.3
Total	100.0	100.0	100.0	100.0

Among whites, the absolute rate of decline in infant mortality from 1987-88 to 1991-92 was similar for all weight groups, except for births under 500 g. Although only 0.1 percent of white live-born infants were delivered less than 500 g, this group accounted for about 12 percent of all white infant deaths. Mortality risks declined 23.1

Table 2
Birthweight-Specific Infant Mortality Risks by Race, North Carolina
1987-88 and 1991-92 Birth Cohorts

Birthweight(g)	Number of Deaths		Mortality Risk[1]		Percent Change	Percent of Total Decline
	1987-88	1991-92	1987-88	1991-92		
White						
<500	129	141	969.9	933.8	-3.7	1.9
500-1,499	398	329	322.8	244.8	-24.2	37.0
1,500-2,499	190	163	29.4	21.9	-25.5	19.2
≥2,500	472	392	3.9	3.0	-23.1	41.9
Black and Other						
< 500	226	232	965.8	935.5	-3.1	3.6
500-1,499	414	386	286.5	228.0	-20.4	45.9
1,500-2,499	135	118	23.8	18.2	-23.5	17.0
≥2,500	325	278	6.0	4.8	-20.0	33.4

[1]Infant deaths per 1,000 live births.

Note: Infants with unknown birthweight are excluded.

percent for normal birthweight infants, 25.5 percent for moderately low birthweight infants, and 24.2 percent for very low birthweight infants. Improved survival of normal birthweight infants accounted for 41.9 percent of the overall decline in white infant mortality during this period. Improved survival of very low birthweight and moderately low birthweight infants accounted for 37.0 percent and 19.2 percent of the overall decline, respectively.

Infants of black and other minority races experienced trends in birthweight-specific mortality that were similar to those seen among whites. All birthweight groups showed substantial declines in infant mortality with the exception of infants delivered less than 500 g, for whom very little improvement was noted. Infants born under 500 g, who comprised 0.4 percent of all live births to minority women, accounted for more than one in five infant deaths in this population. The decline in mortality among normal birthweight, moderately low birthweight, and very low birthweight minority infants was slightly less than that seen for whites (20.0 percent, 23.5 percent, and 20.4 percent, respectively). Comparing the effect of these trends on overall mortality among minorities, improvements in the survival of 500-1,499 g infants accounted for the greatest proportion (45.9 percent) of the total decline. Improved survival among normal birthweight infants accounted for 33.4 percent of the decline, while moderately low birthweight infants accounted for 17.0 percent of the overall decline.

Trends in Birthweight-Specific Neonatal and Postneonatal Mortality

Table 3 shows neonatal and postneonatal mortality risks by race and birthweight group for infants born in 1987-88 and 1991-92. For both whites and minorities, more than 80 percent of the deaths among infants weighing 500-1,499 g occurred during the neonatal period, while for normal birthweight infants, the majority of deaths occurred during the postneonatal period. From 1987-88 to 1991-92, substantial declines in mortality occurred in all subgroups, with the exception of neonatal deaths among normal birthweight minority infants, where the mortality risk remained essentially unchanged. For those infants, a lack of improvement was apparent across all causes of

Table 3
Birthweight-Specific Neonatal and Postneonatal Mortality Risks, by Race 1987-88 and 1991-92 Birth Cohorts

	Number of Deaths		Mortality Risk[1]		
	1987-88	1991-92	1987-88	1991-92	Percent Change[2]
White					
500-1,499					
Neonatal	340	279	275.8	207.6	-24.7
Postneonatal	58	50	64.9	46.9	-27.7
1,500-2,499					
Neonatal	109	101	16.9	13.6	-19.3
Postneonatal	81	62	12.7	8.5	-33.6
2,500+					
Neonatal	193	166	1.5	1.2	-20.2
Postneonatal	279	226	2.2	1.6	-24.9
Black and Other					
500-1,499					
Neonatal	342	321	236.7	189.6	-19.9
Postneonatal	72	65	65.3	47.4	-27.4
1,500-2,499					
Neonatal	74	58	13.0	8.9	-31.5
Postneonatal	61	60	10.9	9.3	-14.4
2,500+					
Neonatal	94	99	1.7	1.7	-2.1
Postneonatal	231	179	4.3	3.1	-28.0

[1] Infant deaths per 1,000 live births. [2] Percent change is calculated from mortality risks carried out to more than one decimal place, and therefore may not match exactly the percent change obtained when calculated from the mortality risks presented in this table.

Note: Infants with unknown birthweight are excluded.

death with the exception of birth defects, in which a slight decline was noted; however, this improvement was offset by an increase in infection-related deaths (data not shown). In all groups except for moderately low birthweight minority infants, the rate of decline in postneonatal mortality exceeded that for neonatal mortality.

Trends in Cause-Specific Infant Mortality

Table 4 shows the cause-specific infant mortality risks, by race, for 1987-88 and 1991-92. Among whites, the leading cause of infant death was birth defects, followed by the combination of prematurity/low birthweight/ respiratory distress, "other perinatal conditions," and SIDS. Examination of the trends in cause-specific mortality over time shows that a decrease in the risk of death from birth defects accounted for a greater percentage of the total decline in white infant mortality than any other cause (27.0 percent). Yet, despite this decrease, birth defects remained the leading cause of death for white infants. Decreased mortality due to respiratory distress accounted for 13.5 percent of the overall decline, while other deaths related to prematurity/low birthweight contributed very little to the improvement in infant mortality.

Table 4
Cause-Specific Infant Mortality Risks by Race
North Carolina, 1987-88 and 1991-92 Birth Cohorts

Cause of Death	Number of Deaths		Mortality Risk[1]		Percent Change[2]	Percent of Total Decline
	1987-88	1991-92	1987-88	1991-92		
White						
Birth Defects	271	220	2.1	1.6	-24.7	27.0
Prematurity/Low Birthweight	121	124	0.9	0.9	-4.9	2.4
Respiratory Distress/BPD[3]	115	88	0.9	0.6	-29.0	13.5
Sudden Infant Death Syndrome	155	149	1.2	1.1	-10.8	6.8
Labor/Delivery Complications	33	24	0.3	0.2	-32.5	4.3
Injuries	42	31	0.3	0.2	-31.5	5.3
Infection	83	63	0.6	0.5	-29.6	9.9
Other Respiratory Conditions	92	72	0.7	0.5	-27.4	10.2
Other Perinatal Conditions	183	162	1.4	1.2	-17.9	13.2
Other Known Causes	107	78	0.8	0.6	-32.4	14.0
Unknown	7	25	0.1	0.2	100.0	-6.5
All Causes	1,209	1,036	9.3	7.4	-20.5	100.0
Black and Other						
Birth Defects	138	125	2.3	1.9	-16.4	12.5
Prematurity/Low Birthweight	176	223	2.9	3.4	17.0	-16.6
Respiratory Distress/BPD	106	85	1.7	1.3	-26.0	15.3
Sudden Infant Death Syndrome	146	114	2.4	1.7	-27.9	22.6
Labor/Delivery Complications	29	19	0.5	0.3	-39.5	6.4
Injuries	40	40	0.7	0.6	-7.7	1.7
Infection	85	82	1.4	1.2	-10.9	5.2
Other Respiratory Conditions	112	96	1.8	1.4	-20.9	13.0
Other Perinatal Conditions	214	171	3.5	2.6	-26.2	31.1
Other Known Causes	74	55	1.2	0.8	-31.4	12.9
Unknown	13	22	0.2	0.3	56.3	-4.1
All Causes	1,133	1,032	18.5	15.6	-15.9	100.0

[1] Infant deaths per 1,000 live births. [2] Percent change is calculated from mortality risks carried out to more than one decimal place, and therefore may not match exactly the percent change obtained when calculated from the mortality risks presented in this table. [3] Bronchopulmonary dysplasia

For each cause of death, the infant mortality risk for blacks and other minorities was higher than that of whites (Table 4). Among minority infants, the leading causes of death were prematurity/ low birthweight, "other perinatal conditions," birth defects, and SIDS. The mortality risk for SIDS showed a rather dramatic decrease, and accounted for 22.6 percent of the overall decline in mortality among minorities. A decrease in mortality attributed to "other perinatal conditions" accounted for 31.1 percent of the decline in infant mortality, while decreased mortality due to respiratory distress and birth defects contributed to 15.3 and 12.5 percent of the decline, respectively. One disturbing trend evident for black and other minority infants is the increase in the risk of mortality due to preterm delivery and low birthweight. The effect of this increase was to hinder by 16.6 percent the rate of decline in overall infant mortality for this group. In other words, had the risk of death from prematurity/ low birthweight remained the same, the overall infant mortality risk for minorities in 1991-92 would have been about 15.1 instead of 15.6. This increased risk is consistent with the trend of an increasing percentage of all births to minorities that were 500-1,499 g.

DISCUSSION

This study demonstrates that the decline in infant mortality that occurred between 1987-88 and 1991-92 in North Carolina was a broad-based phenomenon. The fact that improvements occurred among both whites and minorities, among all birthweight groups, and among a variety of causes suggests that no one intervention or group of interventions was wholly responsible for the overall decline in infant mortality. It is more likely that a range of strategies contributed incrementally to the decline in mortality seen during this period. Several issues emerge from this analysis.

As in other states, North Carolina's progress in reducing infant mortality continues to be related to improvements in birthweight-specific survival rather than to a reduction in the rate of low birthweight.[2-4] Improved survival among infants delivered very low birthweight accounted for about 40 percent of the total decline in the state's infant mortality rate since 1987-88, a notable finding given that less than two percent of all births occur within this weight group. When such improvements in birthweight-specific mortality are observed, attention has tended to focus on the high technology "rescue" interventions provided to preterm and other critically ill newborns in the neonatal intensive care unit. However, as this study demonstrates, improvements in birthweight-specific mortality in North Carolina were not confined to the smallest babies; substantial improvements also occurred among moderately low birthweight and normal birthweight infants. These improvements may be due to factors such as better nutrition, preconceptional risk reduction, and parenting education, as well as improved obstetrical and pediatric care.

With regard to cause-specific mortality, decreases in the risk of death from several causes contributed to the decline in infant mortality. Among whites, a reduced risk of death from congenital malformations was the most important contributor to the decline in infant mortality. This reduction was largely the result of a decrease in deaths due to cardiac defects, a trend that is difficult to explain. Following a period of very little change during much of the 1980s, in 1989, the infant mortality risk due to congenital malformations declined by at least 20 percent for both whites and minorities, and has remained relatively constant ever since. Although increased use of prenatal diagnosis may have contributed to a decline in infant mortality related to neural tube defects and chromosomal anomalies, this procedure would have had very little effect on deaths due to congenital heart disease. Data from the state's birth defects surveillance program do not show a decline in the birth prevalence of cardiac defects since 1987-88; however, because of the low ascertainment of these

defects by the surveillance program, these trends are difficult to interpret. Better morbidity data on the occurrence of cardiac defects and other congenital malformations are needed to examine the factors related to these trends and to develop more effective strategies for the prevention and treatment of birth defects.

Among both whites and minorities, a substantial reduction in mortality from respiratory distress syndrome and other respiratory complications was noted. The availability of surfactant therapy, which came into widespread use during the latter period of this study, is likely to have played a significant role in this improvement.

Among blacks and other minorities, declines in deaths due to SIDS and the category "other perinatal conditions" contributed to much of the reduction in the infant mortality rate. With the exception of labor and delivery complications, these were the only cause of death categories in which the rate of decline was greater for minorities than for whites. The dramatic decrease in SIDS deaths among minority infants in North Carolina is particularly encouraging and warrants further study. In the U.S., SIDS mortality has been declining since the 1980s, although the rate of decline for both whites and minorities has been slower than that observed in this analysis.[5]

The overall improvement in infant mortality among minority infants was somewhat hindered by an increase in deaths from prematurity/low birthweight. About one-half of these deaths were among infants delivered under 500 g, who are unlikely to survive even with the most aggressive medical care. Although the mortality rate among very low birthweight minority infants did improve during the period, this improvement was largely offset by an increase in the number of these deliveries.

Another issue of concern raised in this analysis is the apparent lack of success of the various health initiatives put in place since 1988 to reduce the rate of low birthweight in North Carolina. This finding is particularly troubling because so much of the disparity in infant mortality between whites and minorities is attributable to differences in the incidence of extreme prematurity. There is evidence to suggest that many of these programs, including maternity care coordination[6] and WIC,[7] are effective in reducing the risk of low birthweight; however, for whatever reason, these benefits have not resulted in a reduction in the rate of low birthweight statewide. It is possible that the evident impact of these programs is being diminished by an underlying increase in the overall rate of low birthweight. The increasing adolescent fertility rate, and the increasing percentage of births to women with high parity, short birth-to-conception interval, and other risk factors may support this explanation. Be that as it may, it is clear that current efforts have been insufficient to reverse the adverse trend in low birthweight in North Carolina. Until this problem is effectively addressed, efforts to reduce the disparity in birth outcomes between whites and minorities will meet with limited success.

If birth outcomes in North Carolina are to continue to improve, a broad range of interventions will need to be pursued aggressively. The work to be done in a number of areas is clear. Prenatal interventions that have proven to be effective, such as WIC, must be provided to more of those in need. More women should begin their pregnancies alcohol, drug, and tobacco-free. Unintended pregnancies, and the high risk conditions often associated with them must be prevented more effectively. Risk-appropriate preconceptional, prenatal, delivery, and infant care must be accessible to all, with particular attention directed at those mothers and infants who are at greatest risk. In doing so, we should abandon the false dichotomy between a "medical model" and "public health model," and recognize instead that effective medical and public health interventions complement rather than oppose one another.

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In many areas, we need to develop and implement more effective interventions. Despite years of intensive medical and public health efforts, the problem of preterm birth has remained intractable. At the same time, new opportunities for preventing birth defects, SIDS, and other supposedly "non-preventable" causes of infant morbidity and mortality are now becoming a reality. Prevention of birth defects, low birthweight, and SIDS—which together account for nearly 60 percent of all infant deaths among both whites and minorities—represents the greatest potential for achieving significant reductions in infant mortality and improving the overall health of our children. To achieve this goal will require a better understanding of the biological, environmental, and sociobehavioral risk factors related to these outcomes, so that more effective interventions can be developed and targeted at those populations at greatest risk.

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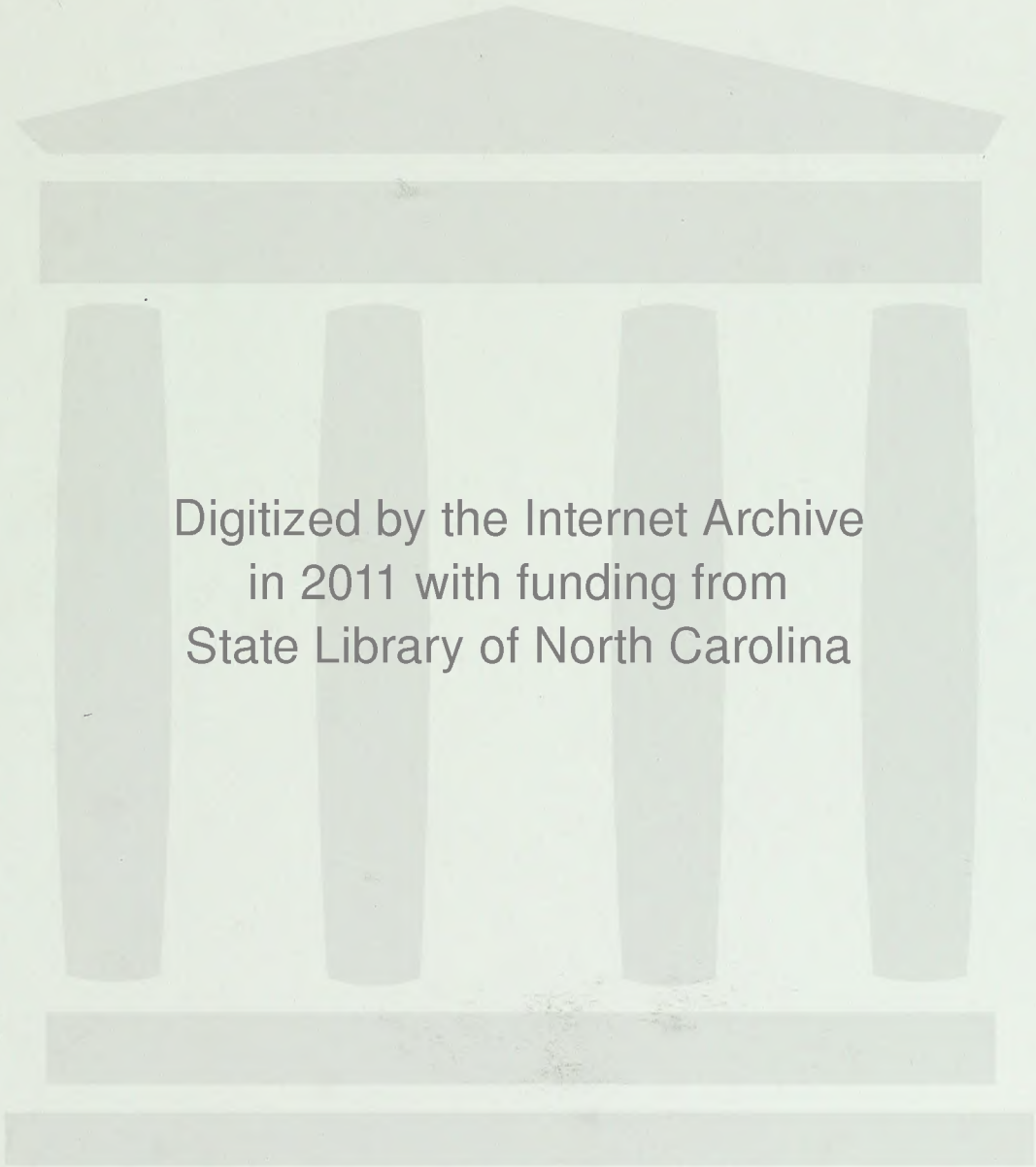

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